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XV.—*Some Activities of Polar Bodies.*

By E. A. Andrews *.

The acceptance of the view that the polar bodies given off by the eggs of animals are but imperfect eggs incapable of fertilization, and having no part to play in the development of the true egg, has naturally tended to lessen interest in their fate. That they often remain attached to the egg for a long time, and that in certain insects, according to Henking, they may remain within the egg or go back again into it, are facts that have seemed of no moment.

A recent paper † having shown that in certain Echinoderms the polar bodies as well as the egg are possessed of remarkable powers hitherto supposed to be limited to certain Protozoa, and that the polar bodies soon become, and may permanently remain, fused with the developing egg, makes it of great interest to inquire whether the polar bodies of other animals have such powers and such opportunities for possibly influencing the development of the egg.

It seems that in the star-fish and the sea-urchin the egg, both before and after fertilization, acts very like many filose Rhizopods—the protoplasm is seen to project itself out from

* From the 'Johns Hopkins University Circulars,' November 1897, pp. 14–16.

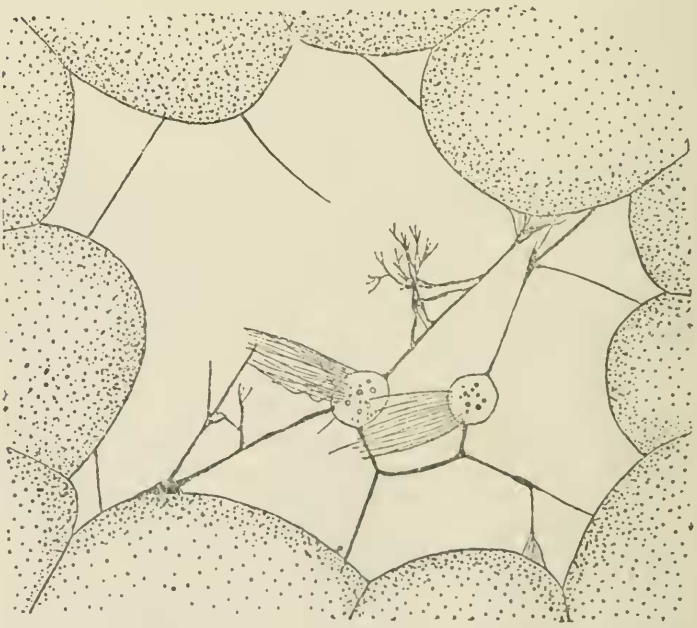
† G. F. Andrews, "Some Spinning Activities of Protoplasm," Journal of Morphology, xii., 1897.

the mass in the form of delicate flowing currents of living material that form filose pseudopodia. These thread-like processes have the power to unite with or separate from one another, to lengthen or to shorten, to become thick or thin, much as do the pseudopodia of *Gromia*. By means of such living material spun out from the cells all parts of the young organism are held together as one continuous mass of living matter, the continuity being established as fast as cell-division tends to interrupt it.

The polar bodies act like the cells of the cleaving egg, and from the first become organically continuous with the egg-cells by means of living threads spun out from the polar bodies and from the egg.

In figure 1 the polar bodies are represented lying over the relatively large opening that leads into the cleavage cavity of

Fig. 1.



the many-celled blastula. This figure is from a camera-lucida sketch made in 1894 with Zeiss ocular 8, objective 2 millim., and draw-tube 170 millim., by G. F. Andrews, from the living blastula of the *Asterias* common at Roscoff, France. Under this magnification of more than one thousand

diameters the polar bodies are plainly connected with each other and with the surrounding cells of the blastula by delicate threads of protoplasm that constantly change. There are also characteristic tufts or brushes of more delicate threads sent out from each polar body; these also constantly change.

It will be noticed that the cells about the orifice also show threads stretching from one to the other as well as to the polar bodies.

On the threads protoplasmic masses flow along to or from the polar bodies or from cell to cell, and on the threads side spinnings may take place, producing such branching, root-like tufts, and anastomosing complexes as are partly represented in the figure.

The peculiar contractile powers of the material of these threads is illustrated in the figure in the case of a curved connective that joins the angle of one process to the angle of another. These processes extend from the two polar bodies to two separate cells on the margin of the orifice or cleavage-pore, and the curved connective seems as if tending to draw the processes closer together by bending itself (compare *loc. cit.* pp. 382–83).

Passing over many significant facts, we note that the polar bodies may pass through the cleavage-pore into the interior of the blastula and be connected with the complicated mass of threads joining the mesenchyme-cells with the ectoderm and entoderm in the gastrula-stage.

Thus in these animals the polar bodies long continue to act like Heliozoa, and acquire a living continuity with the embryo which may extend to the gastrula stage in such a way as to make them permanently part of the organism.

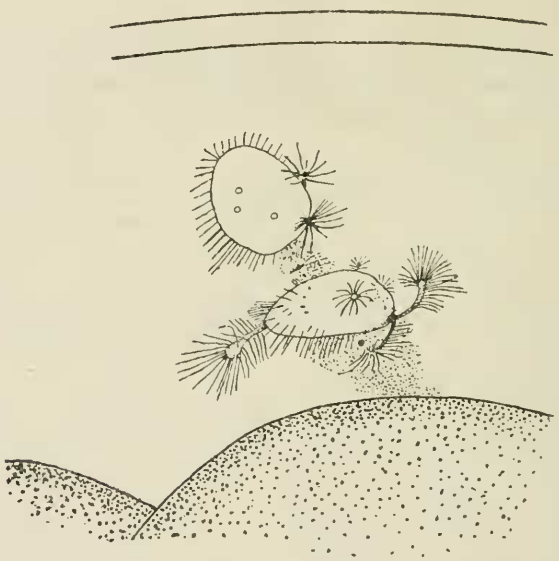
In the large Nemertean, *Cerebratulus lacteus*, Verrill, I find some spinning activities of the egg and its cells and most marked activity of the polar bodies. Soon after their formation the polar bodies send out delicate Heliozoa-like rays, and later characteristic star-like groups of processes that may develop into long proboscis-like outgrowths armed with lateral threads. From the first the polar bodies are continuous with the egg and with one another by means of an exceedingly delicate film of material that sometimes shows fine threads and nodules within it, and seems living protoplasm rather than passive excretion or "slime."

In figure 2 the processes from the two polar bodies are indicated as seen under ocular 8, objective 2 millim., and draw-tube 160 millim., and drawn largely with the camera lucida. The egg was in the four-celled stage and about to divide again, so that there were more than eight cells fifteen

minutes later. The double membrane is indicated by two lines some distance from the egg.

At this period the activities of the polar bodies have passed through their first phases and are gradually approaching their more permanent later phases.

Fig. 2.



A more detailed account of these will be given elsewhere, but we will here note that the polar bodies continue to adhere to one another and to the egg for a long time, even if the membrane be removed and they be exposed to the sea-water. When the larva becomes ciliated the polar bodies break loose and float about in the liquid between the larva and its membranes; but they still adhere to one another and are sometimes seen attached to the egg-membrane. Probably they are lost when the larva breaks out from the egg-membranes.

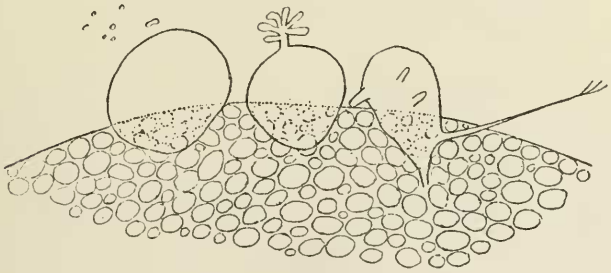
The first and the second polar bodies are markedly different: the first tends to remain more nearly spherical and to continue its radiating Helioza-like activities; the second early assumes somewhat the shape of a spindle, and is prone to send out long polar processes looking from the end view like stars and strongly suggesting *free astrospheres*, and from the side view somewhat like test-tube brushes. In later phases the spindle may be much elongated, slender, and with

a marked astrosphere-like mass at each end, so that the entire figure is strangely like similar appearances in caryokinesis.

With exceptional light some of the spin-threads are seen to pass up to the egg-membrane and to branch; others go to the surface of the egg. Here, as in the starfish, the changes that take place, the making of new processes and the withdrawal and bending of old, make it difficult to represent the actual appearances, even if it were possible to adequately express by black lines the optical effect produced by these clear protoplasmic filaments, which bear as much resemblance to fine spun-glasswork as to any other common gross object.

In a nudibranch mollusk, *Tergipes despectus* (?), there are often three polar bodies that remain in close association till the larva is a pyramidal many-celled mass. In some cases a connexion was seen, a changing process or processes, extending between a polar body and the egg and between one body and another; generally the connexion escaped observation, though the bodies acted as if held together. In the case shown in figure 3 the small objects near the largest polar

Fig. 3.



body were seen to change position, and may have been either foreign or loose particles, or else enlargements upon filose processes so fine as to escape detection with the 6 ocular and 2 millim. objective.

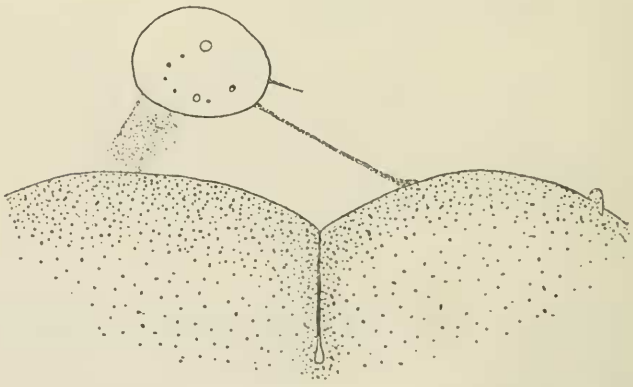
Similar objects near the next polar body proved to be a group of blunt pseudopodia-like outgrowths borne upon a common stalk. From the remaining polar body similar blunt processes projected in various directions separately, and one very long process extended upward to the egg-membrane, where it branched and seemed attached by its several side-threads. This last polar body also sent out a process that apparently attached itself to the surface of the egg, which was still in an undivided state. In other cases blunt processes

and long slender processes were sent out and again drawn in ; within a minute a long slender process extended out from a polar body to the egg, and seemed to join to it, and later was represented by a tuft of short, pointed, contracted processes. In many cases the polar bodies showed amœba-like changes of form, with or without pseudopodia ; in one case where there were but two polar bodies they crawled over one another with much of the appearance of amœbæ, one of them having a tuft of pseudopodia.

In a lamellibranch mollusk, *Nucula delphinodonta*, the formation and activity of the polar bodies was observed only in some eggs that were probably not fertilized and that did not develop beyond an incomplete first cleavage. The two polar bodies were seen to be connected by a cylindrical mass of clear substance, and, as seen in figure 4, one polar body was seen connected to the egg by means of a long filament as well as by an extensive sheet of faintly refracting material similar to that seen in *Cerebratulus*.

In this case the cleavage had passed in toward the centre of the egg. The small eminence on one side illustrates one

Fig. 4.



of the several ectosarcal processes that at first were much like protuberances found in *Cerebratulus*, and there giving rise to brushes of fine spin-threads. Here, however, such ectosarcal processes are followed by hernia-like protrusions containing yolk and indicating the abnormal state of the egg.

With the 8 ocular and 4 millim. objective large star-like radiations and central refracting areas were seen near the first polar body as the second one was being formed. Comparing these with appearances seen with the same powers in

Cerebratulus, there is no doubt that there were here also radiating branches of processes similar to those so common at the ends of the second polar body of *Cerebratulus*. The first polar body also showed very fine Helioza-like radiations in one case. One polar body showed marked amœboid change of outline, with a rounded blunt pseudopodium.

Such amœboid changes of polar bodies are most pronounced in another lamellibranch, *Angulus tener*. As represented in figure 5, the larger, first polar body takes on a somewhat cylindrical shape at a time when the second is rounded and not entirely free from the egg, and sends out blunt pseudopodia, the two bodies remaining closely appressed. Besides

Fig. 5.

the rounded pseudopodia, which are represented as dark, there were also clear delicate lateral sheets or lamellæ of wavy protoplasm, which are indicated in outline. All these parts rapidly changed, as may be seen by comparing the left-hand view with the right, an interval of scarcely a minute having passed between these two sketches of the same polar body. As these observations were made with the 6 ocular and 2 millim. objective, the failure to see spin-threads here does not disprove their existence; in one case there seemed to be something connecting the first polar body with the egg and passing like a filament between them; but the general character of these polar bodies was that of amœbæ, and not that of filose rhizopods.

To sum up: we find that the polar bodies in certain representatives of the groups—Echinodermata, Mollusca, and Nemertini—show marked activities, differing in different groups and in different subgroups. In several groups the polar bodies have not only amœboid but strongly marked Heliozoan activities. The polar bodies in several groups remain vitally connected with one another and with the developing embryo for some time after their extrusion.

How far these phenomena are normal, and how much of what is above recorded may prove to be pathological, cannot be at present decided; but, in any event, it has been shown that the protoplasm of polar bodies has powers hitherto unsuspected. These need not imply close relationship between polar bodies and Protozoa, but may serve to show that protoplasm expresses itself in radically the same characteristic "protoplastic" way in Metazoa and Protozoa. These new facts may be added to those recently presented in a comparative study of protoplasm *, and help to bring us toward the new standpoints there reached.

October 18, 1897.

XVI.—*Heterocera from the Transvaal.*

By W. L. Distant.

I have recently acquired a small collection of moths made in the neighbourhood of Johannesburg, which contains the following apparently undescribed species:—

Family **Arctiidæ**.

Spilosoma lemniscata, sp. n.

Head above golden yellow, eyes and antennæ black; pronotum black, the lateral margins and a round spot at base golden yellow; a black spot at humeral angles; abdomen above ochraceous, with the base, central transverse abdominal fasciæ, and lateral spots black; body beneath and legs dark fuscous, anterior femora streaked with ochraceous.

Anterior wings golden yellow, streaked with black—these streaks consist of a submarginal inner fascia, a fascia beneath cell from base to its extremity, where it emits four branches to outer margin (the uppermost disconnected), a streak from within cell to near margin, and a shorter subapical streak or spot; posterior wings dark purplish brown, with the margins golden yellow. Anterior wings beneath as above, but duller in hue; posterior wings beneath with a large basal subcostal yellow patch.

Exp. wings 31 millim.

Hab. Transvaal, Johannesburg.

Allied to *Spilosoma dissimilis*, Dist.

* G. F. Andrews, 'The Living Substance' (Ginn & Co., 1897).